SOLAR/2038-79/06

Monthly Performance Report

DALLAS RECREATION CENTER

JUNE 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

MONTHLY PERFORMANCE REPORT
DALLAS RECREATION CENTER
JUNE 1979

I. SYSTEM DESCRIPTION

This solar energy system is installed in the North Hampton Park Recreation and Health Center in Dallas, Texas. The building contains an area of 16,000 square feet, which provides room for an 8,000-square foot gymnasium, a locker room and a health care clinic. The solar energy system is designed to provide 30 percent of the annual space heating, 48 percent of the annual space cooling and 90 percent of domestic hot water requirements.

The solar energy system contains 238 single-glazed flat-plate collectors, manufactured by Honeywell, Inc., providing a gross area of 3,650 square feet. The collectors are mounted in 29 arrays on the roof of the building and face south. The collectors are tilted at an angle of 25 degrees from the horizontal. The heat transfer medium is an aqueous solution of 35 percent ethylene glycol. The capacity of the collector loop is 475 gallons.

Space heating is accomplished by the transfer of thermal energy, using heat exchangers, to the air handling system. Space heating is supplemented by a gas-fired boiler. The thermal energy is stored in a 6,000-gallon hot water storage tank which is located above ground in the mechanical room and is insulated with four inches of urethane.

Space cooling is supplied by using solar energy to operate an ARKLA absorption chiller. Chilled water is stored in a 2,000-gallon tank located above ground in the mechanical room and insulated with four inches of urethane. Auxiliary space cooling is provided by two vapor compression units.

Supply water (city) is preheated by heat exchanger HX3 on the hot side of the absorption chiller condenser loop. Preheated water is further heated by heat exchanger HX2, between the hot water storage and the domestic hot water heater (DHW heater). A conventional 100-gallon natural gas water

heater provides additional thermal energy to satisfy the load requirement.

The system, shown schematically in Figure 1, has five modes of solar operation.

Mode 1 - Collector-to-Storage: This mode is entered when either of two collector absorber plate thermal switches close and activate pump P1 at 180°F for cooling and 120°F for heating, respectively. The set points are automatically selected by manual demand switches on the control panel. Additionally, when the solution temperature leaving the collector system exceeds the hot water storage temperature by 20 degrees, pump P2 is energized. This mode continues until the temperature difference is less than three degrees.

Mode 2 - Space Heating: This mode is entered when the HEAT AUTO switch on the console switch panel is in the ON position. Pumps P4 and P5 are energized when valves V3, V6 and V7 on their respective hot water coils begin to open to the coil. At the same time, the control cycle for valves V4 and V5 will be enabled. The signal from an electronic sensor downstream of valve V4, reset by an outdoor electronic sensor, causes valve V5 to be positioned to maintain heating water at a selected temperature. The selected temperature is reset inversely to changes in outdoor temperature.

If the solar heated water temperature becomes too low to supply the heating demand, valve V5 reaches the full open position to storage, a time delay circuit is initiated, valve V5 closes to the storage tank, and valve V4 opens so that hot water from the gas-fired boiler may be used to satisfy the heating loads. The control cycle for valves V4 and V5 has a time delay which is adjustable up to a maximum of five hours. The time delay is to prevent valve oscillations. If, during this cycle, heating requirements are satisfied and valve V4 reaches the fully closed position to the boiler position, another time delay cycle is initiated which will cancel the previous time delay cycle and restore space heating to valve V5 and the solar energy source.

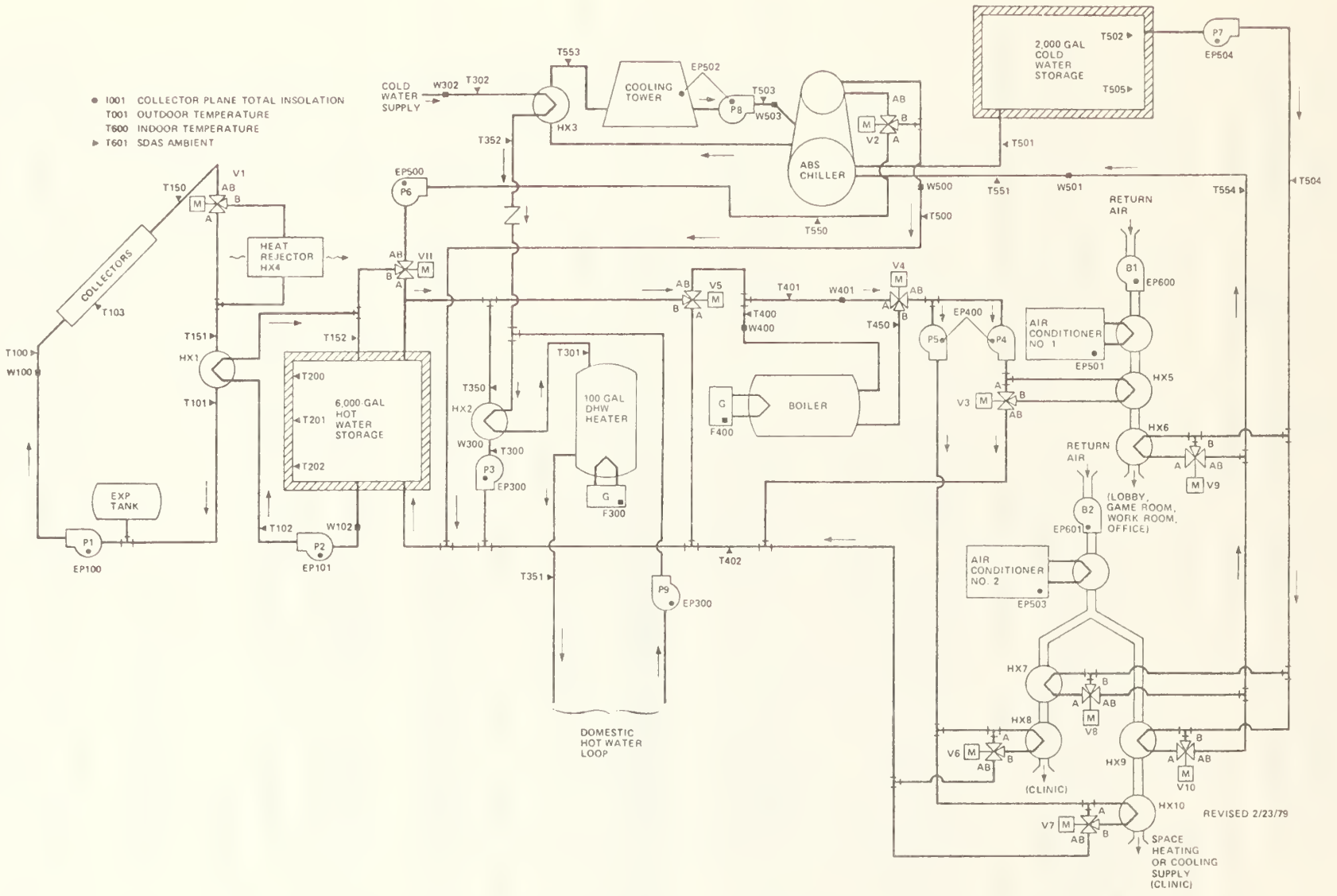

Figure 1. DALLAS RECREATION CENTER SOLAR ENERGY SYSTEM SCHEMATIC

Mode 3 - Space Cooling: When the COOL AUTO switch on the console switch panel is in the ON position, pump P7 starts if any chilled water valve (V8, V9, or V10) is open to the cooling coil. Pump P6 is interlocked to start when pump P7 is started and the absorption chiller control circuit is enabled. Pump P8 and the cooling tower fan are controlled by the absorption chiller controls. Valve V11 will attempt to maintain generator water temperature at 170°F. The chilled water inventory will be maintained by energizing the chiller when chilled water return temperature exceeds 50°F and by de-energizing the chiller at 44°F. If, during the cooling portion of the cycle, cooling demands cannot be met by the chilled water system and any chilled water valve reaches full open to the coil position, a time delay cycle is initiated which closes chilled water valves V8, V9, and V10 to the coils, and enables the respective air conditioning unit to allow the chilled water storage to recover. During this cycle, pump P7 will be locked on to provide required circulation through the chiller. The time delay cycle is adjustable for up to five hours. After the time delay period, the air conditioning unit is de-energized and the solar mode re-entered.

Mode 4 - Excess Heat Rejection: The hot water storage is provided with two alarm thermostats. One initiates an alarm at the central control console when the storage temperature reaches a selected low level. The other thermostat initiates an alarm if the hot water storage temperature reaches a selected high level. At the same time, valve V1 will be positioned to divert collector solution through heat rejector HX4, where excess energy is dissipated to the outside air.

Mode 5 - Domestic Hot Water: Domestic hot water (DHW) is preheated by heat exchanger HX3 when the cooling tower is active. Energy from hot water storage is exchanged at heat exchanger HX2 when pump P3 is on. Pump P9 is on continuously.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data.

The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The solar energy system was turned on in June 1978, and has been operating in conjunction with the auxiliary heating system since that time. Site data acquisition was started on September 4, 1978.

The solar energy system operated continuously during June. The space cooling load was 73.34 million Btu, of which the solar energy system provided 11.60 million Btu and the auxiliary system provided 61.74 million Btu.

A malfunction in the automatic controls for the DHW subsystem resulted in fossil energy being transferred to the hot water storage, which is the reverse of the design plan. Natural gas was turned off to the boiler on April 27, 1979. The natural gas was turned off to eliminate the inadvertent transfer of boiler heated water to the hot water storage due to leakage past three-way valves V4 and V5.

B. Weather

The climatological measured versus long-term values are shown below:

	Long-Term Average	Measured
Ambient Temperature (°F)	80.6	81
Heating Degree-Days (°F-day)	0	0
Cooling Degree-Days (°F-day)	468	494
Insolation (Btu/ft^2-day)	1,989	1,864

C. System Thermal Performance

Collector - Of the 204.2 million Btu of solar energy incident on the collector array during June, only 167.3 million Btu were incident on the array when pump P1 (Figure 1) was operating. The system collected a net energy of 57.5 million Btu, or 28.2 percent of the total insolation incident on the collector array. The operation of pumps P1 and P2 to collect energy required 2.5 million Btu.

Energy loss from the collectors was 1.6 percent of the total energy gained by the collectors. This loss was caused by collector flow occurring when the inlet temperature was greater than the outlet temperature. This condition usually occurred during the last 30 minutes of each day prior to pump P1 turning off. Actual energy lost was 0.96 million Btu. Intentional energy dissipation from the heat rejector HX4 located between the collectors and heat exchanger HX1 was 14.94 million Btu. This is the first recorded operation of the heat rejector since the solar energy system became operational.

Storage - A total of 48.5 million Btu was extracted from storage during the month. The space heating subsystem received no energy from storage. The DHW subsystem received no energy from storage. The space cooling subsystem received 48.5 million Btu from storage. The energy in storage increased by 1.9 million Btu during the month.

The DHW subsystem delivered 0.02 million Btu to storage, which is not a normal mode of operation. A review of the net energy flow in and out of storage is shown below:

Solar energy delivered to storage	51.3	Million Btu
Solar energy from storage	48.5	MIllion Btu
Excess energy	2.8	Million Btu
	2.8	Million Btu
Stored energy change	1.9	Million Btu
Energy loss from storage	0.9	Million Btu

Storage efficiency was 98.2 percent.

Domestic Hot Water - Hot water consumption for June was 2,050 gallons. Average consumption was 68 gallons each day. During June, the average temperature of hot water delivered was 133°F. The hot water consumed was replaced with cold water at an average temperature of 83°F.

During June, no energy was transferred from hot water storage to the DHW heater. Inadvertently 0.02 million Btu was transferred from the DHW heater to the hot water storage. This anomaly was due to a malfunction of the automatic control system.

Space Heating Load - There was no space heating load. On June 28 and 29, 1979, the space heating circulating pumps P4 and P5 operated for approximately 14 hours for unknown reasons. No energy transfer occurred across heating coils HX5, HX8 or HX10, nor was there any flow from the heating coils to the storage tank. Approximately 0.42 million Btu of operating energy was used to circulate water. The automatic control system controlling pumps P4 and P5 appears to have malfunctioned.

Space Cooling Load - The total measured cooling demand was 73.3 million Btu. Of this total, the solar energy system provided 11.6 million Btu, and the auxiliary system provided 61.7 million Btu. The solar cooling system extracted 48.5 million Btu from the hot water storage and required 8.49 million Btu of operating energy.

The auxiliary system, which consists of two air conditioners, used 24.7 million Btu to produce 61.7 million Btu of cooling. The auxiliary system ran each day in June. Total cooling operating energy for June was 44.43 million Btu, of which 11.25 million Btu was used to operate the air-handler fans. The absorption chiller operated 28 days in June. The 48.5 million Btu consumed by the generator of the chiller produced 11.6 million Btu of cooling. This represents a monthly average COP of 0.33. This low COP is due to the chiller operating at times when the return chilled water temperature was within 3°F of the outlet temperature. This is discussed in greater detail in Section II.D.

D. Observations

Automatic Control Problems - The transfer of 0.02 million Btu from the DHW heater to the hot water storage tank is not a normal mode of operation. This is due to the automatic controls not being properly set.

Leaking Three-Way Valve - The adverse effect of water leaking past the three-way valves V4 and V5 was eliminated by turning off the natural gas to the boiler. This prevented boiler heated water from flowing to the storage tank and made possible a performance evaluation of the storage subsystem.

Space Cooling Automatic Controls - The suggested changes which would improve performance are:

1) The absorption chiller control circuit should de-energize the absorption chiller when the chilled water return temperature is less than 44°F. The data from the National Solar Data Network (NSDN) indicate that this control may not be functioning. This control should be checked. When the absorption chiller cycles off, it should remain off for 3 1/2 minutes. For example on June 9, 1979, the chilled water return temperature T551 was approximately 42°F from 1409 to 1553 hours. The absorption chiller appears to have continued functioning during this period.

2) The chilled water tank temperature is being maintained too low. For example, temperature sensor T502 which is located in the top of the chilled water tank registered 41.1°F at 1450 hours on June 9, 1979. At this time the chilled water return temperature sensor T551 registered 42.2°F. Efficiency would increase if the chilled water tank temperature was increased.

3) The auxiliary air conditioners are energized concurrently with the chilled water pump P7. For example, on June 9, 1979, air conditioner number one was energized from 1259 to 1553 hours

while the absorption chiller was operating and pump P7 circulated 51 gallons of chilled water each minute. The chilled water return temperature sensor T554 registered an average of 41°F during this period. With chilled water available at a temperature of 41°F, the building cooling load could have been within the capability of the absorption chiller.

Intentional Heat Rejection - Heat rejector HX4 operated on 28 days during June. This is significant because no prior operation of this overheat protection system has been recorded. On June 28, 1979, at 1101 hours, the fluid temperature leaving the collectors was 203.6°F and after passing through heat rejector HX4 the temperature was 200.2°F. This data provides a measurement of overheat protection capability.

E. Energy Savings

The Dallas Recreation Center solar energy system resulted in a negative savings of 0.01 million Btu of natural gas and 6.32 million Btu of electricity during the month. The negative savings was due to (1) the reverse flow of energy from the DHW tank to the thermal storage tank and also due to leakage past valves V4 and V5 and (2) the cooling load supplied by the absorption chiller required more electricity than would have been required had a conventional air conditioner supplied the load. For example, the operating energy for the chilled water system which includes pumps P6, P7 and P8 used 8.49 million Btu. Assuming a COP of 2.5, this would have produced 21.2 million Btu of cooling from a conventional air conditioner. The total cooling load supplied by the chilled water was 11.6 million Btu.

III. ACTION STATUS

The operation of the absorption chiller was discussed by phone with Frank Marshall on May 24, 1979. In order to operate more efficiently, Frank plans to adjust the absorption chiller controls and install a new condenser high limit switch.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: DALLAS RECREATION CENTER DALLAS, TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE, 1979

SITE/SYSTEM DESCRIPTION:
THE DALLAS RECREATION CENTER SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING, COOLING AND DOMESTIC HOT WATER. THE SYSTEM USES A 35% PRESTON II SOLUTION IN THE COLLECTOR HX LOOP. WATER IS USED AS THE ENERGY STORAGE MEDIUM. HOT WATER FROM THE STORAGE TANK IS DISTRIBUTED TO IN-DUCT COILS FOR SPACE HEATING, TO THE GENERATOR LOOP FOR DOMESTIC HOT WATER HEATING.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	204.153 MILLION BTU
	55932 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	57.518 MILLION BTU
	15758 BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	81 DEGREES F
AVERAGE BUILDING TEMPERATURE	79 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.24
ECSS OPERATING ENERGY	2.462 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	22.633 MILLION BTU
TOTAL ENERGY CONSUMED	111.522 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.898	0.000	73.340	73.924 MILLION BTU
SOLAR FRACTION	100	0	16	17 PERCENT
SOLAR ENERGY USED	-0.006	0.000	48.501	48.470 MILLION BTU
OPERATING ENERGY	0.000	0.418	19.753	22.633 MILLION BTU
AUX. THERMAL ENERGY	4.001	0.000	17.286	4.006 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	24.694	24.694 MILLION BTU
AUX. FOSSIL FUEL	6.668	0.000	N.A.	6.668 MILLION BTU
ELECTRICAL SAVINGS	-0.001	N.A.	-3.857	-6.320 MILLION BTU
FOSSIL SAVINGS	-0.010	0.000	N.A.	-0.010 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.450

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: DALLAS RECREATION CENTER DALLAS, TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE, 1979

SITE/SYSTEM DESCRIPTION:
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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	215.382 GIGA JOULES
	635169 KJ/SQ.M.
COLLECTED SOLAR ENERGY	60.682 GIGA JOULES
	178953 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	27 DEGREES C
AVERAGE BUILDING TEMPERATURE	26 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.24
ECSS OPERATING ENERGY	2.597 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	23.878 GIGA JOULES
TOTAL ENERGY CONSUMED	117.655 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.948	0.000	77.374	77.990 GIGA JOULES
SOLAR FRACTION	100	0	16	17 PERCENT
SOLAR ENERGY USED	-0.006	0.000	51.169	51.135 GIGA JOULES
OPERATING ENERGY	0.000	0.441	20.839	23.878 GIGA JOULES
AUX. THERMAL ENG	4.221	0.000	18.236	4.226 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	26.052	26.052 GIGA JOULES
AUX. FOSSIL FUEL	7.035	0.000	N.A.	7.035 GIGA JOULES
ELECTRICAL SAVINGS	-0.001	N.A.	-4.070	-6.668 GIGA JOULES
FOSSIL SAVINGS	-0.011	0.000	N.A.	-0.011 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.450

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: DALLAS RECREATION CENTER DALLAS,TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	1.521	70	0.000	N	0.000	0.000	-0.000
2	3.186	72	0.001	O	0.022	0.076	0.000
3	7.429	76	2.217	T	0.090	0.476	0.298
4	6.860	79	1.902		0.085	0.264	0.253
5	2.799	76	0.000	A	0.010	0.029	-0.001
6	6.283	81	1.429	P	0.080	0.341	0.227
7	6.339	85	1.615	P	0.080	0.120	0.254
8	6.819	85	1.855	L	0.080	0.426	0.272
9	7.168	83	2.126	I	0.092	0.499	0.296
10	8.472	72	2.397	C	0.101	0.131	0.283
11	8.471	73	2.587	A	0.102	0.150	0.319
12	8.109	76	2.644	B	0.099	0.254	0.326
13	8.088	79	2.667	L	0.100	0.155	0.330
14	8.099	82	2.573	E	0.100	0.062	0.318
15	7.985	81	2.463		0.099	0.092	0.322
16	8.055	81	2.529		0.100	0.073	0.314
17	8.010	81	2.403		0.099	0.366	0.300
18	7.100	82	1.792		0.091	0.454	0.252
19	6.907	86	1.877		0.089	0.517	0.271
20	6.845	88	1.750		0.097	0.533	0.255
21	7.582	87	2.265		0.097	0.554	0.288
22	7.423	87	2.007		0.108	0.143	0.270
23	7.995	86	2.034		0.100	0.000	0.254
24	6.615	86	2.100		0.081	0.205	0.317
25	4.814	77	1.289		0.047	0.040	0.268
26	6.560	80	1.214		0.077	0.444	0.185
27	6.368	83	0.389		0.079	0.441	0.061
28	7.095	86	0.129		0.082	2.465	0.018
29	7.642	92	0.133		0.091	2.713	0.017
30	7.514	92	0.139		0.085	2.915	0.018
SUM	204.153	-	48.526	N.A.	2.462	14.936	-
AVG	6.805	81	1.618	N.A.	0.082	0.498	0.237
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: DALLAS RECREATION CENTER DALLAS, TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE, 1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	1.521	0.000	0.000	71	0.000
2	3.186	1.096	0.208	76	0.065
3	7.429	6.143	2.163	84	0.291
4	6.860	5.377	2.051	88	0.299
5	2.799	0.528	0.005	76	0.002
6	6.283	4.902	1.569	87	0.250
7	6.339	5.015	1.662	91	0.262
8	6.819	5.547	1.835	91	0.269
9	7.168	6.206	2.184	90	0.305
10	8.472	7.306	2.332	78	0.275
11	8.471	7.321	2.594	81	0.306
12	8.109	6.980	2.643	88	0.326
13	8.088	7.002	2.710	89	0.335
14	8.099	7.029	2.510	91	0.310
15	7.985	6.912	2.348	89	0.294
16	8.055	6.959	2.469	89	0.306
17	8.010	6.924	2.583	88	0.323
18	7.100	5.993	1.975	*	0.278
19	6.907	5.779	2.037	92	0.295
20	6.845	5.829	1.914	94	0.280
21	7.582	6.563	2.306	94	0.304
22	7.423	6.876	2.066	96	0.278
23	7.995	6.947	2.315	91	0.290
24	6.615	5.404	1.982	96	0.300
25	4.814	3.260	1.241	86	0.258
26	6.560	4.833	1.743	89	0.266
27	6.368	5.153	1.398	92	0.219
28	7.095	6.136	2.081	94	0.293
29	7.642	6.744	2.251	102	0.295
30	7.514	5.533	2.343	*	0.312
SUM	204.153	167.297	57.518	-	-
AVG	6.805	5.577	1.917	88	0.282
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: DALLAS RECREATION CENTER DALLAS,TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.000	0.000	-0.265	157	-600.920
2	0.230	0.001	0.218	156	0.954
3	2.186	2.217	-0.090	161	0.973
4	1.920	1.902	-0.006	159	0.988
5	0.006	0.000	-0.137	154	-21.223
6	1.628	1.429	0.143	157	0.966
7	1.664	1.615	0.006	159	0.974
8	1.905	1.855	-0.009	161	0.969
9	2.049	2.126	-0.034	160	1.021
10	2.441	2.397	0.022	160	0.991
11	2.639	2.587	-0.016	161	0.975
12	2.637	2.644	-0.016	161	0.997
13	2.652	2.667	0.003	161	1.007
14	2.519	2.573	0.012	162	1.026
15	2.371	2.463	-0.009	162	1.035
16	2.460	2.529	-0.031	160	1.015
17	2.400	2.403	0.003	159	1.002
18	1.909	1.792	0.009	158	0.944
19	1.853	1.877	0.003	160	1.014
20	1.864	1.750	-0.009	160	0.934
21	2.187	2.265	0.022	164	1.046
22	2.061	2.007	0.006	164	0.977
23	2.328	2.034	0.333	166	1.017
24	1.846	2.100	-0.274	163	0.990
25	1.163	1.289	-0.069	158	1.049
26	1.603	1.214	0.386	161	0.998
27	1.369	0.389	1.071	173	1.067
28	0.460	0.129	0.280	191	0.889
29	0.590	0.133	0.298	196	0.730
30	0.354	0.139	0.138	201	0.781
SUM	51.295	48.526	1.989	-	-
AVG	1.710	1.618	0.066	164	0.985
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
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N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: DALLAS RECREATION CENTER DALLAS,TX.
REPORT PERIOD: JUNE,1979

SOLAR/2038-79/06

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.041	100	-0.000	0.000	0.135		0.225	-0.000	-0.001	78	134	84
2	0.008	100	0.000	0.000	0.130		0.217	0.000	0.000	79	133	16
3	0.009	100	0.000	0.000	0.168		0.280	0.000	0.000	77	133	18
4	0.036	100	0.000	0.000	0.131		0.219	0.000	0.000	80	132	76
5	0.046	100	-0.002	0.000	0.133		0.222	-0.000	-0.004	83	132	97
6	0.054	100	0.000	0.000	0.159		0.265	0.000	0.000	82	132	114
7	0.049	100	-0.003	0.000	0.117		0.195	-0.000	-0.004	83	132	108
8	0.038	100	0.000	0.000	0.189		0.316	0.000	0.000	82	133	85
9	0.001	100	0.000	0.000	0.103		0.171	0.000	0.000	79	131	2
10	0.000	0	0.000	0.000	0.098		0.163	0.000	0.000	78	130	0
11	0.041	100	0.000	0.000	0.169		0.282	0.000	0.000	80	133	87
12	0.047	100	-0.001	0.000	0.099		0.165	-0.000	-0.001	83	134	100
13	0.038	100	0.000	0.000	0.137		0.229	-0.000	0.000	83	134	82
14	0.046	100	0.000	0.000	0.142		0.236	0.000	0.000	80	134	99
15	0.033	100	0.000	0.000	0.136		0.226	0.000	0.000	80	134	74
16	0.002	100	0.000	0.000	0.106		0.177	0.000	0.000	80	133	5
17	0.000	0	0.000	0.000	0.162		0.270	0.000	0.000	80	133	0
18	0.038	100	0.000	0.000	0.133		0.222	0.000	0.000	81	133	84
19	0.042	100	0.000	0.000	0.122		0.204	0.000	0.000	82	132	98
20	0.037	100	0.000	0.000	0.164		0.274	0.000	0.000	83	132	87
21	0.040	100	0.000	0.000	0.120		0.200	0.000	0.000	84	132	98
22	0.054	100	0.000	0.000	0.192		0.320	0.000	0.000	86	133	133
23	0.012	100	0.000	0.000	0.092		0.153	0.000	0.000	83	131	29
24	0.001	100	0.000	0.000	0.100		0.167	0.000	0.000	83	132	2
25	0.036	100	0.000	0.000	0.133		0.222	0.000	0.000	85	135	89
26	0.037	100	0.000	0.000	0.121		0.201	0.000	0.000	85	134	91
27	0.033	100	0.000	0.000	0.174		0.290	0.000	0.000	89	132	85
28	0.031	100	0.000	0.000	0.108		0.181	0.000	0.000	91	133	81
29	0.048	100	0.000	0.000	0.121		0.202	0.000	0.000	93	135	122
30	0.002	100	0.000	0.000	0.104		0.174	0.000	0.000	95	134	4
SUM	0.898	-	-0.006	0.000	4.001	N.A.	6.668	-0.001	-0.010	-	-	2050
AVG	0.030	100	-0.000	0.000	0.133	N.A.	0.222	-0.000	-0.000	83	133	68
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

NOT APPLICABLE

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: DALLAS RECREATION CENTER DALLAS, TX.
REPORT PERIOD: JUNE, 1979

SOLAR/2038-79/06

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR. OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.000	0	0.000	0.000	0.000	N	0.000	N	0.000	76	70
2	0.000	0	0.000	0.000	0.000	O	0.000	O	0.000	76	72
3	0.000	0	0.000	0.000	0.000	T	0.000	T	0.000	76	76
4	0.000	0	0.000	0.000	0.000		0.000		0.000	76	79
5	0.000	0	0.000	0.000	0.000	A	0.000	A	0.000	76	76
6	0.000	0	0.000	0.000	0.000	P	0.000	P	0.000	77	81
7	0.000	0	0.000	0.000	0.000	P	0.000	P	0.000	78	85
8	0.000	0	0.000	0.000	0.000	L	0.000	L	0.000	78	85
9	0.000	0	0.000	0.000	0.000	I	0.000	I	0.000	77	83
10	0.000	0	0.000	0.000	0.000	C	0.000	C	0.000	76	72
11	0.000	0	0.000	0.000	0.000	A	0.000	A	0.000	76	73
12	0.000	0	0.000	0.000	0.000	B	0.000	B	0.000	76	76
13	0.000	0	0.000	0.000	0.000	L	0.000	L	0.000	77	79
14	0.000	0	0.000	0.000	0.000	E	0.000	E	0.000	77	82
15	0.000	0	0.000	0.000	0.000		0.000		0.000	77	81
16	0.000	0	0.000	0.000	0.000		0.000		0.000	77	81
17	0.000	0	0.000	0.000	0.000		0.000		0.000	77	81
18	0.000	0	0.000	0.000	0.000		0.000		0.000	78	82
19	0.000	0	0.000	0.000	0.000		0.000		0.000	80	86
20	0.000	0	0.000	0.000	0.000		0.000		0.000	82	88
21	0.000	0	0.000	0.000	0.000		0.000		0.000	83	87
22	0.000	0	0.000	0.000	0.000		0.000		0.000	84	87
23	0.000	0	0.000	0.000	0.000		0.000		0.000	83	86
24	0.000	0	0.000	0.000	0.000		0.000		0.000	82	86
25	0.000	0	0.000	0.000	0.000		0.000		0.000	83	77
26	0.000	0	0.000	0.000	0.000		0.000		0.000	82	80
27	0.000	0	0.000	0.000	0.000		0.000		0.000	87	83
28	0.000	0	0.000	0.169	0.000		0.000		0.000	85	86
29	0.000	0	0.000	0.249	0.000		0.000		0.000	81	92
30	0.000	0	0.000	0.000	0.000		0.000		0.000	78	92
SUM	0.000	-	0.000	0.418	0.000	N.A.	0.000	N.A.	0.000	-	-
AVG	0.000	0	0.000	0.014	0.000	N.A.	0.000	N.A.	0.000	79	81
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE COOLING SUBSYSTEM

SITE: DALLAS RECREATION CENTER DALLAS, TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE, 1979

DAY OF MON.	SPACE COOLING LOAD MILLION BTU	SOLAR FR. OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG DRY BULB TEMP F	AMB TEMP DEG-F
1	1.107	0	0.000	0.000	0.310	0.443	N	0.000	N	76	70
2	0.514	0	0.000	0.000	0.144	0.206	O	0.000	O	76	72
3	0.683	86	2.217	0.619	0.027	0.038	T	-0.058	T	76	76
4	2.580	41	1.900	0.604	0.425	0.608		0.133		76	79
5	2.126	0	0.000	0.000	0.595	0.851	A	0.000	A	76	76
6	2.799	19	1.424	0.495	0.632	0.903	P	-0.031	P	77	81
7	3.384	6	1.615	0.562	0.893	1.276	P	-0.194	P	78	85
8	2.548	10	1.855	0.672	0.643	0.919	L	-0.209	L	78	85
9	1.678	35	2.123	0.658	0.307	0.438	I	-0.083	I	77	83
10	0.651	74	2.397	0.623	0.048	0.068	C	-0.083	C	76	72
11	1.806	49	2.587	0.645	0.260	0.371	A	0.051	A	76	73
12	2.105	68	2.644	0.713	0.190	0.272	B	0.238	B	76	76
13	2.465	40	2.667	0.700	0.415	0.592	L	0.068	L	77	79
14	3.129	18	2.573	0.744	0.714	1.020	E	-0.097	E	77	82
15	3.120	20	2.463	0.721	0.696	0.995		-0.063		77	81
16	1.888	52	2.529	0.688	0.253	0.361		0.061		77	81
17	1.977	42	2.403	0.676	0.320	0.457		0.004		77	81
18	3.119	9	1.791	0.574	0.790	1.129		-0.152		78	82
19	3.659	11	1.875	0.692	0.916	1.308		-0.157		80	86
20	3.960	7	1.747	0.729	1.035	1.478		-0.232		82	88
21	3.724	9	2.265	0.812	0.946	1.351		-0.237		83	87
22	3.479	9	2.007	0.623	0.891	1.273		-0.177		84	87
23	2.015	7	2.034	0.759	0.527	0.753		-0.271		83	86
24	1.904	4	2.098	0.869	0.514	0.734		-0.366		82	86
25	3.210	3	1.289	0.535	0.876	1.251		-0.190		83	77
26	2.527	6	1.213	0.720	0.664	0.948		-0.181		82	80
27	1.248	-4	0.389	1.118	0.374	0.534		-0.334		87	83
28	3.243	-3	0.124	1.116	0.941	1.344		-0.391		85	86
29	4.264	-3	0.133	1.024	1.236	1.765		-0.450		81	92
30	2.427	-3	0.139	1.062	0.706	1.009		-0.455		78	92
SUM	73.340	-	48.501	19.753	17.286	24.694	N.A.	-3.857	N.A.	-	-
AVG	2.445	16	1.617	0.658	0.576	0.823	N.A.	-0.129	N.A.	79	81
NBS	Q502	N500	Q500	Q503	Q501		Q508	Q512	Q514	N406	N113

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@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: DALLAS RECREATION CENTER DALLAS,TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE,1979

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	417	N	70	71	N	N	N
2	873	O	72	76	O	O	O
3	2035	T	76	84	T	T	T
4	1880		79	88			
5	767	A	76	76	A	A	A
6	1721	P	81	87	P	P	P
7	1737	P	85	91	P	P	P
8	1868	L	85	91	L	L	L
9	1964	I	83	90	I	I	I
10	2321	C	72	78	C	C	C
11	2321	A	73	81	A	A	A
12	2222	B	76	88	B	B	B
13	2216	L	79	89	L	L	L
14	2219	E	82	91	E	E	E
15	2188		81	89			
16	2207		81	89			
17	2194		81	88			
18	1945		82	*			
19	1892		86	92			
20	1875		88	94			
21	2077		87	94			
22	2034		87	96			
23	2190		86	91			
24	1812		86	96			
25	1319		77	86			
26	1797		80	89			
27	1745		83	92			
28	1944		86	94			
29	2094		92	102			
30	2059		92	*			
SUM	55932	N.A.	-	-	-	-	-
AVG	1864	N.A.	81	88	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
THERMODYNAMIC CONVERSION EQUIPMENT

SITE: DALLAS RECREATION CENTER DALLAS, TX. SOLAR/2038-79/06
REPORT PERIOD: JUNE, 1979

DAY OF MONTH	EQUIPMENT LOAD MILLION BTU	THERMAL ENERGY INPUT MILLION BTU	OPERATING ENERGY MILLION BTU	ENERGY REJECTED MILLION BTU	COEFFICIENT OF PERFORMANCE (SEE NOTE)
1	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000
3	0.860	2.217	0.293	3.079	0.388
4	1.012	1.900	0.291	2.630	0.533
5	0.000	0.000	0.000	0.000	0.000
6	0.720	1.424	0.248	2.099	0.505
7	0.319	1.615	0.272	1.890	0.197
8	0.343	1.855	0.309	2.104	0.185
9	0.782	2.123	0.316	2.865	0.368
10	0.705	2.397	0.275	3.037	0.294
11	1.052	2.587	0.301	3.719	0.407
12	1.520	2.644	0.333	4.071	0.575
13	1.147	2.667	0.326	3.698	0.430
14	0.774	2.573	0.328	3.270	0.301
15	0.814	2.463	0.316	3.295	0.330
16	1.185	2.529	0.333	3.660	0.469
17	1.022	2.403	0.330	3.378	0.425
18	0.529	1.791	0.270	2.302	0.295
19	0.499	1.875	0.313	2.323	0.266
20	0.419	1.747	0.338	2.148	0.240
21	0.540	2.265	0.376	2.650	0.238
22	0.455	2.007	0.296	2.374	0.227
23	0.256	2.034	0.323	2.043	0.126
24	0.299	2.098	0.394	2.437	0.142
25	0.189	1.289	0.224	1.260	0.146
26	-0.070	1.213	0.243	0.998	-0.058
27	0.022	0.389	0.300	0.000	0.057
28	0.264	0.124	0.344	0.000	2.127
29	0.280	0.133	0.390	0.000	2.105
30	0.291	0.139	0.417	0.000	2.100
SUM	16.227	48.501	8.500	61.329	0.335
AVG	0.541	1.617	0.283	2.044	0.011

* DENOTES UNAVAILABLE DATA.
@-DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.
NOTE:

*U.S. GOVERNMENT PRINTING OFFICE: 1979-640-189/4049. Region 4.